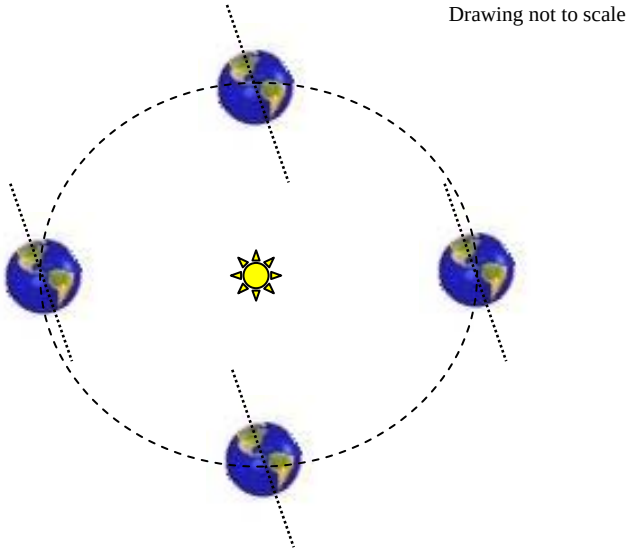
NATS102 SP04 Name:_____

Causes of the Seasons

I. Earth-Sun Distance

The table below lists the distance, in kilometers (km), between the Sun and Earth for each month of the year. The drawing below shows four different locations of Earth during its orbit around the Sun. Note that for each location drawn, Earth is correctly shown with its rotational axis tilted at an angle of 23.5°.

Month	Earth-Sun Distance (km)
January	148,000,000
February	149,200,000
March	150,500,000
April	151,500,000
May	152,800,000
June	154,000,000
July	154,400,000
August	152,800,000
September	151,800,000
October	151,200,000
November	150,500,000
December	150,200,000



Drawing of Earth-Sun System

1. Using the information from the table, does Earth stay the same distance from the Sun throughout the year? If not, what month(s) and during which season (for the northern hemisphere) is Earth closest to the Sun? Farthest from the Sun?

2. How many kilometers is the difference between the maximum and minimum distances for Earth and the Sun during a complete orbit (one year)? Is the difference in distance Earth undergoes during a complete orbit enough to cause the change in seasons? Explain your reasoning.

3. Is the average temperature of the surface of Earth, at your location, approximately the same during each month of the year?

4. Are the seasons (summer or winter) the same in the northern and southern hemispheres at the same time? When it is summer in the northern hemisphere, what season is it in the southern hemisphere?

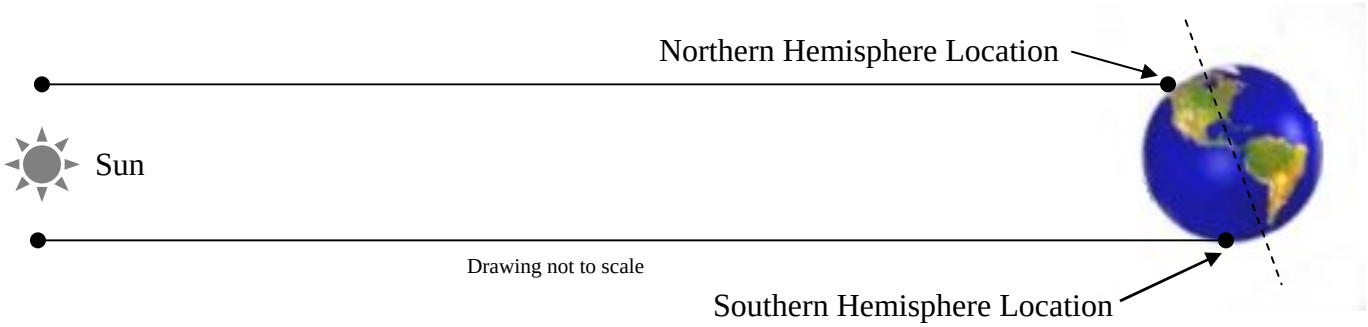
5. Consider the following debate between two students about the cause of the seasons.

   Student 1: *I know that it's hotter in the summer and colder in the winter so we must be closer to the Sun in the summer than in the winter.*

   Student 2: *I disagree. Although the distance between Earth and the Sun does change throughout the year, I don't think Earth is always closer during summer and farther during winter. So, I don't believe that the seasons and changes in Earth's surface temperature are caused by the distance between the Sun and Earth.*

   Do you agree or disagree with either or both students? Explain your reasoning for each.

At different times of the year, locations in the northern hemisphere can be a few thousand kilometers closer to (or farther from) the Sun than locations that are at the same latitude in the southern hemisphere (as shown in the drawing below). However the distance between Earth and the Sun is on average about 150 million kilometers.



6. Could these differences in distance between locations at the same latitude in the northern and southern hemispheres be the cause of the seasons? Explain your reasoning. (Hint: consider the difference in distance for the Sun and Earth found in question #2.)

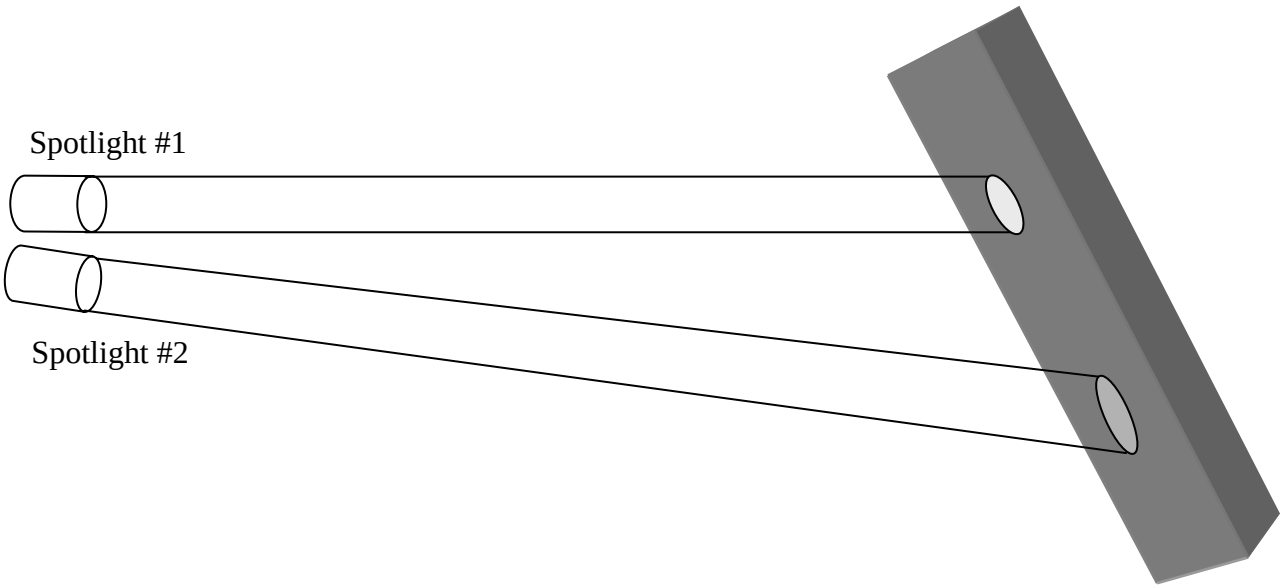
7. Consider the following debate between two students about the cause of the seasons.

   Student 1: *I get it. So since the Earth is tilted there are times when the northern part is closer to the Sun than the southern part. So the north has summer and the south has winter. And then later the south is tilted toward the Sun and gets closer and has summer.*

   Student 2: *I disagree. Although the tilt does bring one hemisphere closer to the Sun, the distance is really small. I mean compared to how much closer and farther Earth gets during different times of the year as it orbits the Sun the difference in distance from tilt is almost nothing.*

   Do you agree or disagree with either or both students? Explain your reasoning for each.

II. Direct Light and Tilt



Consider the picture shown above in which two spotlights (#1 and #2) are shown casting light onto a screen. Note: each spotlight gives off the same total amount of light.

8. Which of the two lighted areas (the one created by spotlight #1 or #2) would appear brighter?

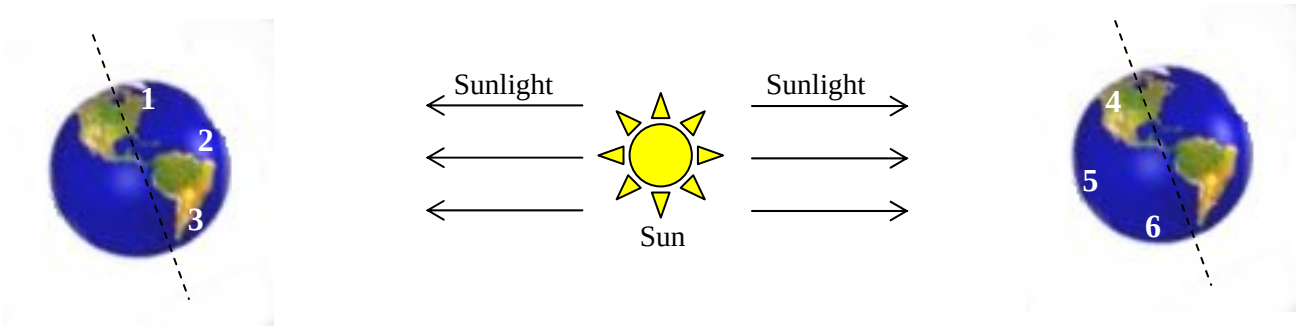
9. Which of the two lighted areas is smaller?

10. Which of the two lighted areas receives more direct light (amount of energy on each unit of area) from the spotlight?

11. If a thermometer were placed in each of the lighted areas, which one would read the higher temperature?

12. Which of the two positions would be similar to the way the sunlight would shine on the southern hemisphere of Earth during winter?

Consider the drawing shown below illustrating three different regions of Earth (the northern hemisphere, the southern hemisphere and the equatorial region) at two different times of the year, 6 months apart.



Note: this drawing is not to scale. In fact you could fit more than 11,000 Earths between the Sun and the Earth.

13. Which number(s) (1-6) corresponds with summer in the northern hemisphere? Explain your reasoning.

14. Which number(s) (1-6) corresponds with winter in the southern hemisphere? Explain your reasoning.

15. Which number(s) (1-6) corresponds with winter in United States? Explain your reasoning.

16. Which number(s) (1-6) corresponds with summer in Australia? Explain your reasoning.

17. Would the seasons change over the course of the year for someone at a location on the equator? Why or why not?

18. Consider the student explanation below regarding question 16.

    Student: *Number 3 is when people in Australia would be having summer. Like it shows in the drawing, that's when the southern hemisphere is getting most of the light because it's closer to the Sun then.*

    Do you agree or disagree with this student explanation? Why or Why not?.

III. Amount of Daylight

19. In the blanks below fill in the *approximate* rising and setting times for the Sun at different times during the year for your current location.

Summer:	Sunrise _____am	Sunset _____ pm
Winter:	Sunrise _____am	Sunset _____ pm

20. During which season (summer or winter) would the location you live in receive sunlight for the greatest number of hours? How many hours?

21. How is your answer to the previous question related to the time of year that your location experiences the highest average temperature?

22. How would the number of hours of sunlight change (if at all) over the course of the year for locations on the equator? Explain your reasoning?

IV. Applying the Model of Causes of Seasons

23. If, somehow, the number of daylight hours did not change throughout the year, but Earth was still tilted at 23.5^{o}, would there still be seasons in the northern and southern hemispheres of Earth? Would the temperature difference between the seasons still be as great? Explain your reasoning.

24. If Earth were tilted more (60^{o} rather than 23.5^{o}), would the winter be colder, warmer, or the same? Why?

25. If Earth were tilted 90^{o}, which location would be warmer in summer: the Arctic Circle or Florida? Why?

26. If Earth was upright with no tilt, would the temperature at your location in July be colder, warmer or the same as it is now during the month of July? Why?

27. Is there a region of Earth that experiences very little change in temperature? If not, why not? If so, why?

28. Provide one piece of evidence to support the fact that the varying distance between the Sun and Earth cannot account for the seasons.

29. Which two things are most directly responsible for the cause the seasons on Earth? Explain your reasoning.